

WHAT IS CLAIMED IS:

1. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means  
5 having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means, on a surface to be scanned, to form a plurality  
10 of scan lines; and synchronism-detecting optical means for converging part of the plurality of beams deflected by the deflecting means, on a slit surface by a lens section, thereafter guiding the beams to a synchronism detector, and controlling timing of a scan start  
15 position on the surface to be scanned for each of the plurality of beams by use of a signal from the synchronism detector,

wherein the following condition is satisfied:

$$|\delta M1| \leq \delta Y_{\max} / \tan(\theta_{\max})$$

20 (where

$\delta M1$ : defocus amount in a main scanning section of the beams guided to the synchronism detector and in a view from the slit;

$\delta Y_{\max}$ : permissible dot shift amount per scan line;

25  $\theta_{\max}$ : maximum angle difference between angles of incidence to the slit surface of the beams used for detection of synchronism).

2. The multi-beam scanning optical system according to Claim 1, wherein said permissible dot shift amount per scan line is not more than half of resolution in a sub-scanning direction.

5

3. The multi-beam scanning optical system according to Claim 1, comprising correction means for relatively shifting a focus position in the main scanning section of the beams guided to said  
10 synchronism detector in a direction of the optical axis of said synchronism-detecting optical means from said slit surface.

4. The multi-beam scanning optical system  
15 according to Claim 1, comprising correction means for moving the position of said slit surface or a unit including the slit surface in a direction of the optical axis of said synchronism-detecting optical means.

20

5. The multi-beam scanning optical system according to Claim 1, wherein said lens section is disposed in an optical path between said deflecting means and said slit surface, said optical system  
25 comprising correction means for moving said lens section in a direction of the optical axis of said synchronism-detecting optical means.

6. The multi-beam scanning optical system according to Claim 1, wherein at least one lens forming said lens section is integrated with said scanning optical means, said optical system comprising  
5 correction means for moving at least one lens of the lens section not integrated with the scanning optical means, and said slit surface in a direction of the optical axis of said synchronism-detecting optical means.

10

7. The multi-beam scanning optical system according to Claim 1, wherein said lens section is integrated with said scanning optical means, said optical system comprising correction means for moving  
15 at least one optical element of the scanning optical means in a direction of the optical axis of the scanning optical means and for moving said slit surface in a direction of the optical axis of said synchronism-detecting optical means.

20

8. The multi-beam scanning optical system according to Claim 1, wherein at least one lens forming said lens section is integrated with said scanning optical means, said optical system comprising  
25 correction means for moving at least one lens forming the scanning optical means in the main scanning direction.

9. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced  
5 apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means, on a surface to be scanned, to form a plurality of scan lines; and synchronism-detecting optical means  
10 for converging part of the plurality of beams deflected by the deflecting means, on a slit surface by a lens section, thereafter guiding the beams to a synchronism detector, and controlling timing of a scan start position on the surface to be scanned for each of the  
15 plurality of beams by use of a signal from the synchronism detector,

said multi-beam scanning optical system comprising correction means for correcting a dot shift per scan line on the surface to be scanned, which occurs because  
20 of a defocus amount  $\delta M1$  in a main scanning section of the beams guided to the synchronism detector and in a view from the slit surface.

10. The multi-beam scanning optical system  
25 according to Claim 9, wherein said dot shift is not more than half of resolution in a sub-scanning direction.

11. The multi-beam scanning optical system according to Claim 9, wherein said plurality of light-emitting regions are spaced apart from each other in the main scanning direction and in the sub-scanning direction.

12. The multi-beam scanning optical system according to Claim 11, wherein a slit in said slit surface is inclined in the sub-scanning direction according to the dot shift per scan line on said surface to be scanned.

13. The multi-beam scanning optical system according to Claim 11, comprising rotating means for rotating said slit surface or a unit including the slit surface about the optical axis of the synchronism-detecting optical means according to the dot shift per scan line on said surface to be scanned.

14. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means on a surface to be scanned, to form a plurality

of scan lines; and synchronism-detecting optical means  
for guiding part of the plurality of beams deflected by  
the deflecting means, to a synchronism detector by a  
lens section and controlling timing of a scan start  
5 position on the surface to be scanned for each of the  
plurality of beams by use of a signal from the  
synchronism detector,

wherein the following condition is satisfied:

$$|\delta M2| \leq \delta Y_{\max} / \tan(\theta_{\max})$$

10 (where

$\delta M2$ : defocus amount in a main scanning section of  
the beams guided to the synchronism detector and in a  
view from a photoreceptive surface of the synchronism  
detector;

15  $\delta Y_{\max}$ : permissible dot shift amount per scan line;

$\theta_{\max}$ : maximum angle difference between angles of  
incidence to the photoreceptive surface of the beams  
used for detection of synchronism).

20 15. The multi-beam scanning optical system  
according to Claim 14, wherein said permissible dot  
shift amount per scan line is not more than half of  
resolution in a sub-scanning direction.

25 16. The multi-beam scanning optical system  
according to Claim 14, comprising correction means for  
relatively shifting a focus position in the main

scanning section of the beams guided to said synchronism detector in a direction of the optical axis of said synchronism-detecting optical means from the photoreceptive surface of the synchronism detector.

5

17. The multi-beam scanning optical system according to Claim 14, comprising correction means for moving the position of said synchronism detector or a unit including the synchronism detector in a direction of the optical axis of said synchronism-detecting optical means.

10

18. The multi-beam scanning optical system according to Claim 14, wherein said lens section is disposed in an optical path between said deflecting means and said synchronism detector, said optical system comprising correction means for moving said lens section in a direction of the optical axis of said synchronism-detecting optical means.

15

20

19. The multi-beam scanning optical system according to Claim 14, wherein at least one lens forming said lens section is integrated with said scanning optical means, said optical system comprising correction means for moving at least one lens of the lens section not integrated with the scanning optical means, and said synchronism detector in a direction of

25

the optical axis of said synchronism-detecting optical means.

20. The multi-beam scanning optical system  
5 according to Claim 14, wherein said lens section is integrated with said scanning optical means, said optical system comprising correction means for moving at least one optical element of the scanning optical means in a direction of the optical axis of the  
10 scanning optical means and for moving said synchronism detector in a direction of the optical axis of said synchronism-detecting optical means.

21. The multi-beam scanning optical system  
15 according to Claim 14, wherein at least one lens forming said lens section is integrated with said scanning optical means, said optical system comprising correction means for moving at least one lens forming the scanning optical means in the main scanning  
20 direction.

22. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means  
25 having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing



the plurality of beams deflected by the deflecting means, on a surface to be scanned; and synchronism-detecting optical means for converging part of the plurality of beams deflected by the deflecting means, on a slit surface by a lens section, thereafter guiding the beams to a synchronism detector, and controlling timing of a scan start position on the surface to be scanned by use of a signal from the synchronism detector;

10        wherein, where  $\delta M1$  is a defocus amount in a main scanning section of the beams guided to the synchronism detector and in a view from the slit surface and  $\delta X$  is a defocus amount at each image height on the surface to be scanned, the following condition is satisfied:

15         $|\delta X - \delta M1| \leq \delta Y_{\max}/\theta_{\max}$

(where

$\delta Y_{\max}$ : permissible dot shift amount per scan line;

20         $\theta_{\max}$ : maximum angle difference between angles of incidence to the slit surface of the beams used for detection of synchronism).

23. The multi-beam scanning optical system according to Claim 22, wherein said permissible dot shift amount per scan line is not more than half of resolution in a sub-scanning direction.

24. The multi-beam scanning optical system

according to Claim 22, comprising correction means for relatively shifting a focus position in the main scanning section of the beams guided to said synchronism detector in a direction of the optical axis of said synchronism-detecting optical means from said slit surface.

25. The multi-beam scanning optical system according to Claim 22, comprising correction means for moving the position of said slit surface or a unit including the slit surface in a direction of the optical axis of said synchronism-detecting optical means.

26. The multi-beam scanning optical system according to Claim 22, wherein said lens section is disposed in an optical path between said deflecting means and said slit surface, said optical system comprising correction means for moving said lens section in a direction of the optical axis of said synchronism-detecting optical means.

27. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to

deflecting means; scanning optical means for focusing  
the plurality of beams deflected by the deflecting  
means, on a surface to be scanned, to form a plurality  
of scan lines; and synchronism-detecting optical means  
5 for converging part of the plurality of beams deflected  
by the deflecting means, on a slit surface by a lens  
section, thereafter guiding the beams to a synchronism  
detector, and controlling timing of a scan start  
position on the surface to be scanned for each of the  
10 plurality of beams by use of a signal from the  
synchronism detector;

where  $\delta M1$  is a defocus amount in a main scanning  
section of the beams guided to the synchronism detector  
and in a view from the slit surface and  $\delta X$  is a defocus  
15 amount at each image height on the surface to be  
scanned, said multi-beam scanning optical system  
comprising correction means for correcting a dot shift  
per scan line on the surface to be scanned, which  
occurs because of a difference between the two defocus  
20 amounts  $\delta M1$ ,  $\delta X$ .

28. The multi-beam scanning optical system  
according to Claim 27, wherein said dot shift is not  
more than half of resolution in a sub-scanning  
25 direction.

29. The multi-beam scanning optical system

according to Claim 27, wherein said plurality of light-emitting regions are spaced apart from each other in the main scanning direction and in the sub-scanning direction.

5

30. The multi-beam scanning optical system according to Claim 29, wherein a slit in said slit surface is inclined in the sub-scanning direction according to the dot shift per scan line on said surface to be scanned.

10

31. The multi-beam scanning optical system according to Claim 29, comprising rotating means for rotating said slit surface or a unit including the slit surface about the optical axis of the synchronism-detecting optical means according to the dot shift per scan line on said surface to be scanned.

15

32. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means on a surface to be scanned; and synchronism-detecting optical means for guiding part of the

20

25

plurality of beams deflected by the deflecting means,  
to a synchronism detector by a lens section and  
controlling timing of a scan start position on the  
surface to be scanned by use of a signal from the

5. synchronism detector,

wherein, where  $\delta M2$  is a defocus amount in a main  
scanning section of the beams guided to the synchronism  
detector and in a view from a photoreceptive surface of  
said synchronism detector and  $\delta X$  is a defocus amount at  
10 each image height on the surface to be scanned, the  
following condition is satisfied:

$$|\delta X - \delta M2| \leq \delta Y_{\max} / \theta_{\max}$$

(where

$\delta Y_{\max}$ : permissible dot shift amount per scan line;

15  $\theta_{\max}$ : maximum angle difference between angles of  
incidence to the photoreceptive surface of the beams  
used for detection of synchronism).

33. The multi-beam scanning optical system  
20 according to Claim 32, wherein said permissible dot  
shift amount per scan line is not more than half of  
resolution in a sub-scanning direction.

34. The multi-beam scanning optical system  
25 according to Claim 32, comprising correction means for  
relatively shifting a focus position in the main  
scanning direction of the beams guided to said

synchronism detector in a direction of the optical axis of said synchronism-detecting optical means from the photoreceptive surface of the synchronism detector.

5           35. The multi-beam scanning optical system according to Claim 32, comprising correction means for moving the position of said synchronism detector or a unit including the synchronism detector in a direction of the optical axis of said synchronism-detecting  
10           optical means.

          36. The multi-beam scanning optical system according to Claim 32, wherein said lens section is disposed in an optical path between said deflecting  
15           means and said synchronism detector, said optical system comprising correction means for moving said lens section in a direction of the optical axis of said synchronism-detecting optical means.

20           37. An image forming apparatus comprising the multi-beam scanning optical system as set forth in either one of Claims 1 to 36; a photosensitive member placed on said surface to be scanned; a developing unit for developing an electrostatic latent image formed on  
25           said photosensitive member with scanning light by said multi-beam scanning optical system, into a toner image; a transfer unit for transferring said developed toner

image onto a transfer medium; and a fixing unit for fixing the transferred toner image on the transfer medium.

5           38. An image forming apparatus comprising the multi-beam scanning optical system as set forth in either one of Claims 1 to 37; and a printer controller for converting code data supplied from an external device, into an image signal and entering the image  
10 signal into said multi-beam scanning optical system.

          39. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means  
15 having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means, on a surface to be scanned, to form a plurality  
20 of scan lines; and synchronism-detecting optical means for converging part of the plurality of beams deflected by the deflecting means, on a slit surface by a lens section, thereafter guiding the beams to a synchronism detector, and controlling timing of a scan start  
25 position on the surface to be scanned for each of the plurality of beams by use of a signal from the synchronism detector,

wherein a dot shift per scan line on the surface to be scanned, which occurs because of a defocus amount  $\delta M1$  in a main scanning section of the beams guided to said synchronism detector and in a view from said slit surface, is not more than half of resolution in a sub-scanning direction.

40. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means, on a surface to be scanned, to form a plurality of scan lines; and synchronism-detecting optical means for guiding part of the plurality of beams deflected by the deflecting means, to a synchronism detector by a lens section and controlling timing of a scan start position on the surface to be scanned for each of the plurality of beams by use of a signal from the synchronism detector,

wherein a dot shift per scan line on the surface to be scanned, which occurs because of a defocus amount  $\delta M2$  in a main scanning section of the beams guided to said synchronism detector and in a view from a photoreceptive surface of said synchronism detector, is



not more than half of resolution in a sub-scanning direction.

41. A multi-beam scanning optical system  
5 comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced apart from each other in a main scanning direction; to deflecting means; scanning optical means for focusing  
10 the plurality of beams deflected by the deflecting means, on a surface to be scanned, to form a plurality of scan lines; and synchronism-detecting optical means for converging part of the plurality of beams deflected by the deflecting means, on a slit surface by a lens  
15 section, thereafter guiding the beams to a synchronism detector, and controlling timing of a scan start position on the surface to be scanned for each of the plurality of beams by use of a signal from the synchronism detector,

20 wherein, where  $\delta M1$  is a defocus amount in a main scanning section of the beams guided to said synchronism detector and in a view from said slit surface and  $\delta X$  is a defocus amount at each image height on said surface to be scanned, a dot shift per scan  
25 line on the surface to be scanned, which occurs because of a difference between the two defocus amounts  $\delta M1$ ,  $\delta X$ , is not more than half of resolution in a sub-

scanning direction.

42. A multi-beam scanning optical system comprising incidence optical means for guiding a plurality of beams emitted from light source means having a plurality of light-emitting regions spaced apart from each other in a main scanning direction, to deflecting means; scanning optical means for focusing the plurality of beams deflected by the deflecting means, on a surface to be scanned, to form a plurality of scan lines; and synchronism-detecting optical means for guiding part of the plurality of beams deflected by the deflecting means to a synchronism detector by a lens section and controlling timing of a scan start position on the surface to be scanned for each of the plurality of beams by use of a signal from the synchronism detector,

wherein, where  $\delta M2$  is a defocus amount in a main scanning section of the beams guided to said synchronism detector and in a view from a photoreceptive surface of said synchronism detector and  $\delta X$  is a defocus amount at each image height on said surface to be scanned, a dot shift per scan line on the surface to be scanned, which occurs because of a difference between the two defocus amounts  $\delta M2$ ,  $\delta X$ , is not more than half of resolution in a sub-scanning direction.